Long Term Monitoring of the SNO Photomultiplier Tubes

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During the early phase of the SNO detector operation, the ultrapure water, in which the photomultiplier tubes and the high voltage connectors were immersed, was degassed because of biological growth and radon background concerns. Subsequently some of the underwater high voltage connectors exhibited breakdown behavior in this degassed water environment. The gaskets in the connectors are permeable to gases and thus, in principle, the air within the connectors will diffuse out leaving a lower pressure within the connector with a correspondingly lower breakdown voltage. This high voltage breakdown effect was eliminated by re-gassing the water with radon-free liquid nitrogen from boil off.

We produced three panels of 23 photomultiplier tubes (PMT) each for long-term monitoring of the PMTs in the ultrapure water environment. One of these Berkeley Underwater Tube Testing Sleds (BUTTS) was deployed to the ultrapure water region outside the photomultiplier support geodesic in May 1999. A rigging system to deploy the sled was also constructed in the SNO underground laboratory. In Figure 1, a picture of the deployed sled is shown. The other two sleds are being reserved for making *in situ* tests of new connector designs if the replacement of the current connectors is necessary.

In the preparation phase of this deployed sled, extra attention was paid to ensuring the high voltage connectors were connected to the PMTs in the same manner as in the main detector. For example, original fabrication components, ranging from the ABS plastic PMT mounting cell to the high voltage grease used in the connector, were used in this sled. Original procedures, for example, the torque used in the cabling, were also followed. This sled was deployed to a depth of about 20 feet. If one needs to inspect the high voltage connectors for any reason, the sled can be retrieved from the SNO cavity with minimum effort.

The PMTs in this sled are connected to the SNO electronics, and their signals are processed in the same manner as the inward-facing PMTs in the PMT geodesic. During the operation of this sled, we found that it is also useful for tagging some background events in the detector.

Figure 1: One of the Berkeley Underwater Tube Testing Sleds being depolyed underground in SNO.